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(54) **Bladderless tyre moulding apparatus and method of operating same.**

(57) A bladderless tyre mould press (10) comprising lower and upper platens (11,12), means (17) for moving the platens relatively towards one another from an open position to a closed moulding position, the platens (11,12) mounting means (22,23) for moulding the tyre side walls and means (36) for moulding the tyre tread, and each of the platens (11,12) mounting means (37,38) for moulding a respective tyre bead (28,29), the tyre bead moulding means (37,38) including central means (26,27) movable relative to the respective platen for insertion into the centre of the tyre.

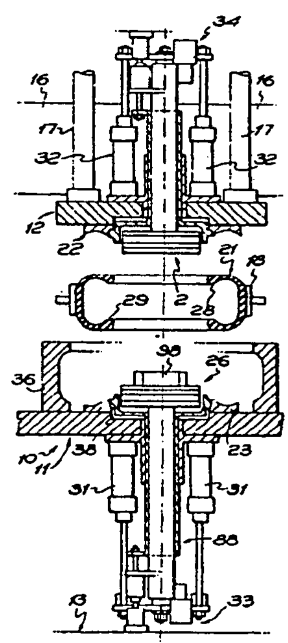

FIG.1A

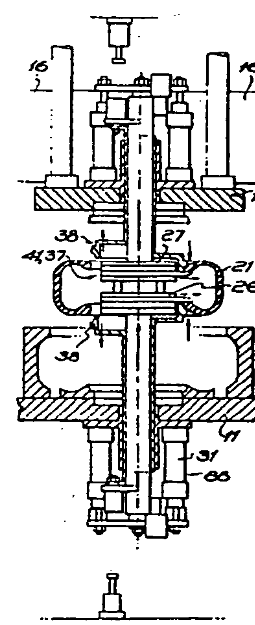

FIG.1B

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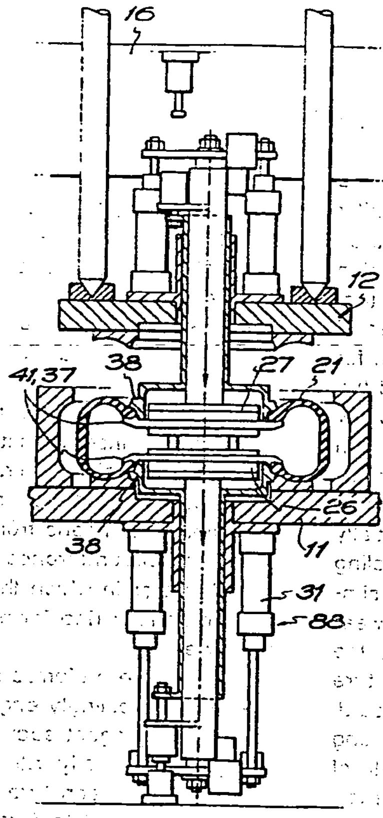


FIG.1C

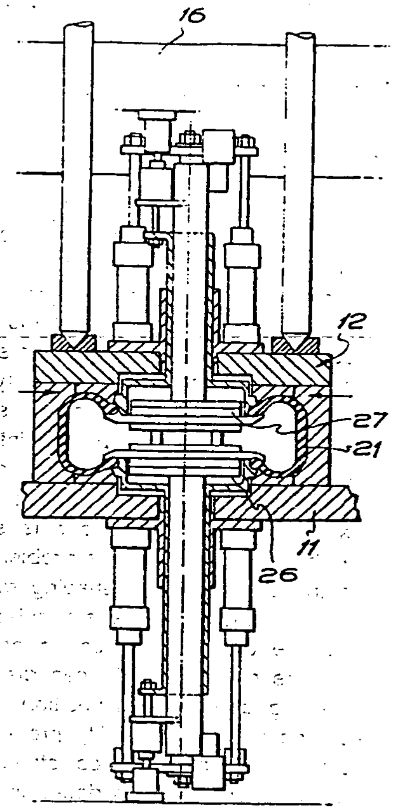


FIG.1D

BLADDERLESS TYRE MOULDING APPARATUS AND METHOD OF OPERATING SAME

The present invention relates to a bladderless tyre moulding apparatus and method of operating the same.

In conventional tyre technology, a so called "green" tyre is produced which is generally similar to the final shape of the tyre, the green tyre then being loaded into a tyre moulding press which includes a mould for curing the "green" tyre; that is, completing the cross-linking of the polymer of the "green" tyre. The mould includes surfaces, for example, to produce the tread on the tyre, and the tyre is pressed against the mould surfaces by means of an internal bladder passed into the green tyre and through which the curing medium (which is usually steam or hot water) passes. The use of bladders in such mould presses is substantially universal, because it makes the problem of sealing to retain the curing and preshaping medium simpler. However, the bladders are subject to wear and there are other difficulties. In particular, the uneven nature of the bladder can distort the tyre during shaping, and affect its position in the mould, thus resulting in serious quality problems relating to uniformity and performance standards, all of these being major factors in determining the market acceptance of the tyre.

Other advantages of eliminating the bladder is the higher heat transfer rate (from the curing medium to the tyre) which results in shorter cure times, and eliminates the press down time to change bladders. Consequently, this may reduce the number of extremely expensive moulding presses and mou lds that are required.

Bladderless moulding will also result in significant reduction in operating costs due to the elimination of the bladder costs, the elimination of the green tyre inside painting operation, and in energy saving.

A further quality advantage is that the ridges imparted to the inside of the tyre by the bladder vent grooving will be eliminated, so avoiding possible local distortion of the tyre ply cords.

A number of proposals have been made to remove the bladder and to produce a bladderless tyre mould press, but despite these proposals, bladderless tyre mould presses are rare or unknown in a factory environment for the large scale production of tyres.

The tyre moulding press to be described includes a lower platen, an upper platen, and means for moving them relatively towards one another to a moulding position. The upper and lower platen mount means to mould the tyre side walls and means to mould the tyre tread. In the arrangement to be described the tread mould is provided by separate tread moulding pieces mounted on the lower platen and means may be provided to move the tread moulding pieces towards and away from a moulding position.

The means for moving the upper platen may be attached to a fixed beam positioned over the bottom platen and the upper platen may move vertically up and down and may be accurately positioned by means of linear guides forming part of the press side frames or columns.

In the press to be described, each of the lower and upper platens mount a central means which may be inserted into the centre of a green tyre, each of which central means includes a tyre bead moulding means, means to expand the bead moulding means from a first diameter less than the inner circumference of the green tyre, to a larger diameter in which the bead moulding means forms an annular ring for moulding the bead of the green tyre.

In the preferred arrangment, the bead moulding means sealingly engage with the green tyre so that a curing agent such as hot water or steam may be passed directly into the interior of the green tyre to cure the green tyre, pressure being applied by the curing agent to force the green tyre into engagement with the surrounding mould parts to mould the outer surface of the green tyre and to seal the green tyre bead against the bead ring which will mould the outside surface of the tyre bead.

The tyre bead moulding means may comprise a plurality of sectors which, in the expanded position of the bead moulding means engage with one another to provide a moulding surface for moulding the inside surface of the bead of the tyre.

A bladderless tyre mould press will now be described by way of example only and with reference to the accompanying drawings in which:-

Figures 1A to D show diagrammatic vertical sections through a press according to the invention showing the press in a sequence of positions during closure of the press,

Figures 2A to E show des 2A to E show diagrammatic vertical sections through a press according to the invention showing the press in a sequence of positions during opening of the press,

Figure 3 shows a plan view of a sector plate forming a part of a centre mechanism of the tyre press, with the sectors of the sector plate expanded,

Figure 4 shows a view similar to Figure 3 of the sector plate with the sectors retracted,

Figure 5 shows a vertical section on the line 5-5 of Figure 3,

Figure 6 shows a vertical section on the line

6-6 of Figure 3,

Figure 7 is a view of an upper surface of a first, lower, cam plate,

Figure 8 an under view of the undersurface of a second, upper, cam plate,

Figure 9 shows a part vertical section showing the means for controlling the sectors of the sector plate,

Figure 10 shows a plan view of alternative mechanism for operating one of the set of sectors of the sector plate shown in Figures 3 and 4,

Figure 11 shows a plan view of an alternative arrangement of apparatus for operating the other set of sectors of the sector plate shown in Figures 3 and 4,

Figure 12 is a vertical section through the arrangement of Figure 10 (to the left of the axis) and Figure 11 (to the right of the axis),

Figures 13A to 13C show different constructions of cross section of the bead of a green tyre,

Figures 14A to 14C show the bead of a tyre and the bead forming part of the tyre press during operation of the tyre press,

Figures 15A to 15J show cross sections of different arrangements of edges of the sectors, and,

Figures 16A to D shows details of operation of the press between the stages of operation shown in Figures 1B and 1C.

Referring to Figures 1A to D there is shown tyre mould press 10 comprising a lower platen 11 and an upper platen 12. The lower platen 11 is mounted to the ground 13 by a frame, not shown. The upper platen 12 is mounted to an upper beam 16 and is moveable up and down with respect to the beam 16 by means of hydraulic rams 17. (Screw type actuators may be used in place of rams 17 and other rams to be described.) A loader mechanism 18 is provided to be moveable into a position between the lower and upper platen when the upper platen is raised as shown in Figure 1A. In Figure 2D, an unloader 19 is illustrated in a similar position to that of the loader 18, the unloader 19 being removable from the position between the lower and upper platens.

The loader 18 mounts a so-called green tyre 21 in Figure 1A, the green tyre being a tyre which is formed of uncured or part-cured material.

The lower surface of the upper platen 12 incorporates a side wall mould 22 for moulding the side walls of the tyre and the upper surface of the lower platen 11 incorporates a similar side wall mould 23. Each of the lower and upper platens mount a respective centre mechanism 26,27, the primary purpose of each of which is to engage, seal, and mould the inner circumferential edge (referred to as the "bead" 28,29 respectively) of the green tyre. Movement of each centre mechanism 26,27 axially with respect to their respective platens is controlled by means of hydraulic ram systems 31,32 respectively. (Rams 31, 32 could be replaced by screw actuators.)

Lower platen 11 also movably mounts a segmental tread mould means 36.

There is also provided rotary actuators 33,34 for rotating relevant parts of the respective centre mechanisms 26,27 for purposes which will be described later.

The centre mechanisms 26,27 each comprise two parts 37,38, part 37 being adapted to engage the inside of the respective bead 28,29 when expanded, and part 38 being arranged to engage the outside of the respective bead 28,29.

Operation of these parts will now be described. Figures 1A to 1D show closure of the press 10 and Figures 2A to 2D show opening of the press.

Referring firstly to Figures 1A to 1D and in particular, Figure 1A, the tyre press 10 is arranged so that the upper platen 12 is withdrawn upwardly to the maximum extent from the lower platen 11. The loader 18 may then load a green tyre 21 into the "loading" position shown. As shown in Figure 1B, the centre mechanisms 26,27 are then moved by hydraulic rams 31,32 towards one another, meeting in the loading position.

Although the process will be described in more detail later, each centre mechanism 26 is then operated to engage and grip its respective bead 28,29 of the green tyre. This is done by expanding the parts 37 of the centre mechanisms 26,27 and moving upwardly and downwardly annular bead mould parts 38 of respective centre mechanisms 26,27. In this way, the green tyre 21 can be supported on the two centre mechanisms 26,27 and due to the force exerted by the parts 37 the tyre beads clamped and sealed against the bead rings 38, which will enable a low internal pressure to be applied, such as a first stage shaping operation, without risk of pulling the ply cords around the tyre bead coils. This arrangement will also ensure that both beads are accurately positioned and that the tyre treatment is symetrical. The parts 37,38 each include bead moulding sections so that the beads 28,29 of the green tyre can be moulded.

The loader 18 is then disengaged from the green tyre 21 and the centre mechanisms 26,27 and upper platen 12 move down together until the green tyre 21 is in its moulding position shown in Figure 1C, in which the lower side wall of the green tyre 21 engages with the side wall mould 23.

Then the upper platen 12 is moved down so that the side wall mould 22 engages the side wall of the green tyre 21 and the tread mould means 36 are moved into engagement with the green tyre 21.

In this position, it will be seen that the outer surfaces of the green tyre 21 is entirely surrounded

by moulding surfaces comprising tread mould means 36, side wall moulds 22,23, and bead moulds formed by the parts 37,38. Furthermore, the parts 37,38 sealingly engage with the bead of the green tyre 21 and so in the position Figures 1D, a curing medium can be passed to the interior of the green tyre 21.

It is not necessary to provide a bladder since, the tyre is sealingly engaged with the parts 37,38 of the centre mechanisms 26,27 and so, in the position shown in Figure 1D, the curing medium which may be steam or hot water or a mixture of both under pressure is applied directly to the inside of the tyre. The effect of this is to expand the tyre so as to properly engage with the various moulds surrounding it, and thereafter to cure the tyre.

When the curing medium has been applied for a sufficient length of time for the green tyre 21 to be cured, (which varies from, say, 8 - 12 minutes for car tyres to about 60 minutes for truck tyres) the curing medium is removed and if that is steam, then it is simply a matter of shutting off the steam supply, and exhausting the inside of the tyre to atmosphere. To open the tyre mould press from the position shown in Figure 2A, which corresponds to that in Figure 1D, the segmental tread mould means 36 are withdrawn and the upper platen 12 and the centre mechanisms 26,27 are lifted to the position shown in Figure 2B.

With bladderless curing it will be necessary to remove any residual condensate or hot water remaining inside the tyre after the curing medium has been exhausted.

It may be possible to achieve this in position Fig 2A by reducing the pressure inside the tyre to below atmospheric pressure, and so causing any residual water to be flashed off as ste = m.

Alterntively this may be carried out in position Fig 2B by either of the following sequences:-

i) Withdraw the bottom bead ring 38 together with tyre bead 29 until it is lower than the tyre sidewall in which case the residual water will flow out through the centre mechanism 26.

ii) If the tyre does not consistantly stick to the bead ring then the following alternative sequence may be used:-

a) Withdraw the bottom bead ring 3B slightly and partly retract the bottom bead plate 37 so as to create openings through which water may escape.

b) close the bead ring 38 to re-clamp the tyre bead.

c) partially lower the bottom centre mechanism 26, to open the tyre so that the distance between the beads is wider than the width of the tyre.

d) the water should then flow out through the openings created by the partially retracted sectors of the sector plate 37.

e) the lower centre mechanism is then raised to enable the unloader to be placed into position as shown in Fig 2C.

Because of the considerable compression forces created betwen the tyre bead and mould parts 37,38, it is sometimes difficult to dislodge the tyre, and this results in the tyre bead becoming kinked following which the tyre must be scapped or downgraded. Any straining of the tyre bead is undesirable.

Referring to Fig 2C, it will be seen that the unloader 19 is moved into position around the tyre, and that the gripper segments 20 (approx 200°) will be closed until they nearly contact the tyre adjacent to the beads 28,29.

In this position the annular parts 38 of the centre mechanism may be withdrawn. If they cannot overcome the force causing the tyre to stick, then parts 38 will pull and hold the tyre against the unloader segments. This will enable the sectors 37 to be retracted.

The centre mechanism 26,27 can then be withdrawn, and if necessary this will increase the force acting on parts 38 to ensure that they overcome any undue tyre sticking forces. The tyre will now be retained and held by the gripper segments 20 of the unloader 19.

The tyre has now been disengaged from all parts of the mould as shown in Figure 2D and may be removed by means of the unloader 19.

We now refer to Figures 3 to 9 which give details of the part 37 of the centre mechanisms 26,27 which engage with the inside surface of the bead 28,29 of the tyre.

The part 37 comprises a sector plate 41, and a plan view of a sector plate 41 is shown in Figure 3. The sector plate 41 comprise two sets of sectors 42 and 43. The sectors 42,43 are arranged alternately and, when the sectors 42,43 are expanded as in Figure 3, the peripheral edges 46,47 of the sectors 42,43 form a circle 44. The sector plate 41 illustrated is the lower sector plate mounted to the lower platen 11 but the either top sector plate is the same.

Referring to the sectors 42, it will be seen that in addition to an arcuate edge 46, each plate includes two straight edges 48,49 each of which extend from the peripheral edge 46 towards one another rearward end 50 so that the overall plan shape of the sectors 42 are approximately segmental.

Sectors 43 have two straight edges 51,52 extending away from a peripheral edge 47, and parallel to adjacent straight edges 48 or 49 of adjacent sectors 42, and two further straight edges extending from the rear end of the straight edges 51,52, the further straight edges 53,54 extending generally

towards one another rearwardly from the respective straight edges 51 or 52 to a rearward end 56.

The straight edges 48,49 of the sector 42 include grooves 63, and the straight edges 51,52 of the sectors 43 include outwardly directed tongues 64 which engage in the groove 63 of the adjacent sectors 42.

Mounted below the plane of the sectors 42,43 is a mounting plate 57 (see Figures 5 and 6, the mounting plate 57 being circular, the outer periphery 58 of which is coaxial with, but of lesser radius than the circle 44. The plate 57 incorporates in its top surface a radial 'T' section slot 59 for each of the sectors 42 and 43.

It will be seen from Figures 5 and 6 that each of the sectors 42,43 includes, below the upper plate surface, a T-Section tongue 62 which engages in the T-Section slot 59.

In the case of the sector 42, a cam follower 66 is provided which downwardly extends from the tongue 62. Below the mounting plate 57 there is mounted a cam plate 67 the upper surface of which is illustrated in Figure 7, the cam plate 67 including cam grooves 68 into which the cam followers 66 extend.

In the case of the sectors 43, each sector 43 includes an upwardly extending cam follower 69 and above the sector plate 41 there is mounted a second cam plate 71 illustrated in Figure 8 including cam grooves 72, each cam follower 69 engaging in a respective cam groove 72.

It will be understood from the above description and in particular, from Figure 9 that in the case of the upper sector plate, the upper side of the peripheral edge 46 of the upper sector plate 41 is used to mould the inside surface of the bead 28 and lower side of the peripheral edge of the lower sector plate 41 is utilised to mould the inside surface of the bead 29 of the tyre 21. Thus, the diameter of the circle 44 is greater than the minimum diameter of the bead 28, 29. To reduce the effective diameter of the sector 42 from that shown in Figure 3 to that shown in Figure 4, it is necessary to move the sectors 42 and 43 inwardly with respect to the axis. This is done by rotating the cam plates 71 and 67. Rotation of the cam plate 71 will cause the cam followers 69 to move from the outermost end of the cam grooves 72 towards the innermost end thereby urging the cam followers 69 radially inwardly. This movement of cam followers 69 radially inwardly withdraws the sectors 43 inwardly away from the outer peripheral edge. The cam plate 67 may also be rotated to cause the cam follow ers 66 to move from the outermost end of the cam grooves 68 towards the inner most end of the cam grooves 68 and thereby move radially inwardly towards the axis, causing the sectors 42 to move radialy inwardly. The sectors 42 and 43 may be withdrawn to the position shown in Figure 4. During this inward movement of the sectors 42,43, they are guided by engagement of the tongues 62 with the slot 59.

In this way, the maximum outer diameter of the sector plate 41 in the position shown in Figure 4 is less than the diameter of the bead.

Thus, when each sector plate 41 is in the configuration shown in Figure 4, it may be inserted into the interior of the tyre, then expanded to the configuration shown in Figure 3 at which point the sectors 42,43 can engage with the inside surface of the beads 28,29. After curing, the sectors may be withdrawn so that the sector plate 41 takes the configuration shown in Figure 4 and the sector plate 41 withdrawn from inside the cured tyre.

Of course, the sectors 42,43 only mould the interior surface of the beads 28,29. The remaining surfaces of the beads 28,29 are moulded by means of the other annular bead moulding part 38 of the centre mechanism, and each may be provided, as is clear from Figure 9, in the form of a cylindrical member 73, which may be movable axially into and out of engagement with its respective sector plate 41 when extended to the configuration of Figure 3. The outer surface of each cylindrical member 73 adjacent its innermost edge may include a mould surface 74 which moulds the edge and outer surfaces of the bead 28,29.

We now refer in detail to Figure 9. From Figures 1A and 9 it will be seen that the centre mechanism 26 is mounted to the press frame 11 via the hydraulic rams 31 which extend downwardly from below the press frame 11 (the press frame 11 being mounted to the ground by means not shown) and from the lower end of the rams 31 there is provided an upwardly directed column 88. The column 88 mounts at its top end the centre mechanism 26. The axial movement up and down is transmitted to the centre mechanism 26 by means of a centre shaft 91 and the lower end of the outer sleeve 95 acting against the bottom of the tubular shaft 94. The cam plate 71 is mounted by means of a nut 92 engaging a screw threaded upper end of the first shaft 91. The tubular member 89 is surrounded by a tubular shaft 94 which is connected at its upper end to the cam plate 67.

The centre mechanism is operated by the shafts and sleeves which comprise column 88, as follows.

For the sequences Figures 1B and 2D, the centre mechanism is raised and lowered via the rams 31 acting on parts 91,94 and 95, the bead clamping force being increased when the centre shaft 91 pulls the top cam plate 71 against the bead ring 38 after this has registered in the bottom sidewall mould 23 (During press closing the centre mechanism is forced down by the press rams 17

acting against the rams 31).

The sector plate 41 is expanded and retracted by rotation of the centre shaft 91 and the tubular shaft 94, which causes rotation of the cam plates 67,71 via the rotary actuator 31 and a suitable gear train (not shown). The relative rotary motion is such that the sectors 42,43 move at differential speeds to their respective retracted and extended positions, and the edges 51,52 remain in close proximity to edges 48,49 and the tongues and grooves 63,64 remain engaged to ensure that the sectors remain aligned with each other.

The inner sleeve 89 is splined at its lower end with outer sleeve 95 to prevent it from rotating and the mounting plate 57 is prevented from rotating by means of dowel pins projecting from the inner sleeve 89.

When the centre mechanism is in the raised position clearance will exist between the top cam plate 71, the bottom cam plate 67, and the mounting plate 57, so as to enable the cam plates to be rotated and for the sectors to be easily moved in and out.

On the bottom column the outer shaft 94 will drop so that it rests against the outer sleeve 95, whereas on the top column means will be provided to pull up the outer shaft 94 so that it presses up against the outer shaft 95.

This clearance is removed when the centre mechanism is lowered into the mould as these parts are tightly clamped together due to the action of a buffer or springs.

Changing to a different bead diameter is achieved by simply removing the nut 93, on both the top and bottom central mechanisms, lifting out the following parts, and replacing them with parts appropriate to the required bead diameter

- Top cam plate 71.
- Sector plate 41.
- Mounting plate 57.
- Bottom cam plate 67.
- Bead ring 73.
- Spacer Ring 98 (Bottom Mechanism only).

Changing over to a different tyre section (eg 145, 155, 165, 245) may not require any changes at all, or may be restricted to the spacer ring 98, or to the sector plate 41, or to the bead ring 73 or to a combination of these.

Seals are provided at the top of shafts and sleeves 91, 89, 94 and 95 to retain the curing and shaping medium within the inside of the tyre.

The upper surface of the centre mechanism 26 mounts an annular spacer ring 98 contacting the centre mechanism 27 so as to restrain further movement of the two centre mechanisms 26, 27 towards each other.

This annular spacer ring 98 also serves to transmit the full press closing force to form the tyre bead shape during the final mould closing stages. Any excess material in the green tyre beads 28, 29 or any protrusion above the bead ring 38 would in effect oppose the mould closing force and would become compressed or moulded to shape, dependant upon its plasticity at this stage.

At the upper, head end of the column 88, there is provided a connection 96 for a hose for supplying the curing medium, and a connection 97 for exhaust of the curing medium.

The top and bottom centre mechanisms and columns are generally similar except for:-

- the spacer ring 98 attached to the bottom mechanism.
- the curing medium connections in the bottom column.
- the means to pull up the outer shaft 94 on the top column.

Figures 16A to 16D show in some more detail operation of the press between the positions shown in Figures 1B and 1C. These details will now be understood having explained in detail the arrangement of the sector plates 41.

Referring to Fig 16A it will be seen that ram 31 is acting upwards to raise the centre mechanism 26 and that the bead ring actuating ram is acting down to lower the bead ring.

Sleeve 94 has dropped slightly to rest on its bottom end and so provides clearance between the cam plates 67, 71 and the sector plate 41. The sector plate 41 is expanded into the green tyre after it has been placed in position.

In this position, the parts 38 which are retracted are then moved towards one another and towards their respective sector plates 41. This is carried out by expansion of the bead actuating ram as shown in Figure 16B. The initial movement is to clamp the beads 28, 29 of the tyre 21 and in this position the parts 38 do not engage the sector plates 41, but are held apart by the beads which still have a high modulus at this stage (also refer to Figures 14A and 14B).

In Fig 16C the bottom centre mechanism has been moved down to its moulding position and the top centre mechanism to within 1 to 4 m.m of its fully closed position, as follows:-

The press rams 17 act to force both the top and bottom centre mechanism down until the bottom centre mechanism registered in the bottom sidewall mould, the closing force being transmitted by the top ram 32 (outlet valve closed) pressing the top centre mechanism 27 against the bottom central mechanism 26 via the spacer ring 98 the pressure in rams 31 being released as the bottom centre mechanism decends. Pressure is then admitted to ram 31 causing it to expand so as to increase the clamping pressure on the green tyre bottom bead by pulling the sector plate 41 against

the bead ring 38.

Immediately prior to this the outer sleeve 95 will have contacted a buffer causing the bead sector plate 41 to be tightly clamped between the cam plates 67,71.

Simultaneously the pressure inside the rams 32 will be released to enable the top platen 12 to decend to within 1 to 4 mm of its fully closed position, and which will also bring a buffer into contact with the outer sleeve 95 of the top column 88. (This can be seen more clearly by reference to Figures 1C and 1D.)

Pressure is then admitted to expand rams 32 so raising the top centre mechanism until the bead ring 38 becomes registered in the top sidewall mould 22. This will further increase the compression on the buffer so as to tightly clamp the upper bead sector plate 41 between the cam plates 67,71.

The upward pressure in rams 32 will also increase the clamping force on the green tyre top bead, after the bead ring has registered in the mould and cause the top centre mechanism 27 to separate slightly from the spacer ring 98.

In Fig 16D the press rams 17 lower top platen preferably to within less than 1 mm of its fully closed position, after which the tread sectors 36 may be advanced to form a continuous tread ring.

The top platen is then lowered to contact the tread sectors and the full press closing force applied. This force will also be applied from the top side wall mould to the bottom sidewall mould through the bead rings, bead sector plates, top cam plates and the spacer ring, and will ensure that any gap between the spacer ring and the top mechanism is eliminated. Any protrusion of the green tyre beads will at this stage be subjected to the full press closing force, and the sector plate 41 will become fully engaged with bead ring 38.

Figures 10, 11 and 12 show an alternative arrangement for moving the sectors 42,43. We refer firstly to Figure 10 and the left hand half of Figure 12 which shows the mechanism for moving the sectors 42. In place of the cam follower 66 and cam plate 67 there is provided a downwardly extending pin 106 from each sector 42, a link 107 extending horizontally from the pin 106 to a further pin 108 mounted to a cylindrical member 109.

Rotation of the cylindrical member 109 causes the links 107 to move from their solid line position shown in Figure 10 to the dotted line position, and hence tends to move the pins 106 inwardly thereby moving the corresponding sectors 42 inwardly.

A somewhat similar arrangement is provided for the sectors 43 including pins 111 corresponding to the pins 106, links 112 corresponding links 107 and pins 113 corresponding to pin)8. A cylindrical member 114 is provided cor..sponding to cylindrical member 109. Because the sectors 43 have to move in further than the sectors 42, the link 112 has to be of the shape shown so as to nestle with the other links when the sectors 43 are in the dotted position.

Referring to Figures 14A to 14C, it will be seen that Figure 14A shows the cylindrical bead ring 73 moving into engagement with the bead 28 of the green tyre and with the lower sector plate 41 when in its extended position. The initial movement of the cylindrical bead ring 73 clamps the bead between the cylindrical bead ring 73 and the mould surface 40 of the sector plate 41, see Figure 14B.

In this initial clamping position both tyre beads are accurately located on their respective bead rings and sufficient clamping pressure applied to enable low inflation or shaping pressure to be admitted to shape the green tyre and tension the ply cords of the tyre (in the position shown in Fig 1B). After the centre mechanisms and the green tyre have been properly inserted into the remainder of the mould (as in Fig 1C, 14C and 16C) the downward pressure on the sector plate 41 is greatly increased by the rams 31,32 so as to further shape the beads, and this enables the internal shaping pressure to be increased if this is required. At this stage the top and bottom centre mechanisms are held slightly wider apart than the fully closed position as to enable the tread sectors 36 to be moved to form a complete mould tread ring. The press is then fully closed and the closing pressure transmitted to the sector plates 41 in order to fully compress the green tyre beads, after which the curing medium is admitted (as in Fig 1D and 16D).

Figures 13A to 13C show various construction arrangements of beads 28,29 of green tyres which may usefully be used with the arrangement of sector plates 41 and cylindrical bead ring 73 as described. Figure 13A is a conventional construction. In Figure 13B, the thickness of the material in the toe region 30 is increased by extending one of the inner liners into the toe region, and in Figure 13C, this thickness is further increased by adding a packing strip between the bead ring itself and the toe 30 of the bead.

The mould surface 40 of each sector plate 41 has hitherto been described as a simple shaped area of generally conventional shape. Other arrangements may be utilised in order to enhance the seal between the tyre bead and the mould, either by virtue of the sector shape or by means of maintaining pressure on the tyre bead independent of the curing medium pressure and of the initial compression forces required to form the bead shape. This applies particularly during the period when the polymer in the green tyre becomes plasticised and before cross linking of the polymer (curing) is completed.

Figure 15A shows a conventional arrangement similar to that already described. In Figure 15B, the mould surface 40 includes serrations 101 which restrict the flow of material in the bead away from the toe during moulding. In Figure 15C, the mould surface 40 is provided by a replaceable profiled pad 102 so that different profiles may be used for, for example, different tyres. In Figure 15D, a profile is provided in which adjacent the toe of the bead, there is provided a slot 103 between the mould surfaces 40 and 74 into which material from the bead 28,29 may flow to produce a lip seal around the bead toe of the cured tyre.

In Figure 15E the mould surface 74 is provided by a spring steel strip 104 mounted to the outer periphery of the sector plate 41, to improve sealing with the bead 28,29, by applying a pressure thereto. This will maintain pressure on the tyre bead even if the amount of material is insufficient to obtain a seal with an otherwise non-flexible surface. In order to avoid producing a step at the outer edge of the sector plate this may be slit at intervals so as to reduce the edge pressure on the green tyre, or the outer edge may be curved up.

In Figure 15F and 15G the mould surface 74 is provided by a spring plate 76 as illustrated, Figure 15F illustrating the position of the spring plate 76 at the beginning of the curing process, and Figure 15G showing the position of the spring plate 76 at the mid point of the curing process. Any lack of pressure on the bead 28,29 due to insufficient material, or to the increase in plastsicity, is taken up by movement of the spring plate 76, away from the sector plate 41. The spring plate 76 is mounted by a screw 77 to the outer surface of the sector plate 41. In an alternative design in Fig 15H an arcuate bar is provided at the bead toe position urged down by multiple springs 78 in order to increase the sealing pressure at this critical position. The springs 78 will be arranged in an arc above the arcurate bar.

A further arrangement of spring plate 76 is shown in Figures 15I and 15J, Figure 15I showing the alternative arrangement at the beginning of the cure and Figure 15J the same arrangement partway through the cure. In this case, the spring plate 76 is urged downwardly into engagement with the bead by means of a plurality of spring 79.

The principle benefit of the arrangements of Figure 15 F/G/H/I/J is that the spring plates can be forced back against the solid sector plate during the green tyre bead clamping and forming operations, thus allowing the full press closing force to be absorbed by the solid part of the sector.

However, the internal forces generated within the tyre bead when this is compressed will lbecome dissipative as the plasticity increases and material flow takes place. The bead of course will be subjected to the curing medium inflation pressure but this will not have any effect on shaping the inside bead profile, and in particular the bead toe.

The spring plates are free at this stage to open or expand and maintain pressure on the tyre beads independent of the press closing forces and curing pressure and so influence the inside bead shape and in particular in forming the bead toe and in ensuring that an effective seal is obtained at this critical point.

These spring plates will also function if the volume of material in the green tyre bead is slightly less than the equivalent mould volume.

It is however, preferable that the volume of material in the green tyre bead should be slightly in excess of the mould volume as the compressive forces generated will assist in moulding the bead shape. any excess material will flow outward on either side of the bead core.

The action of the spring plates will be to influence the flow of material towards the bead toe and to maintain or increase the sealing pressure at this point.

When the cross linking of the polymers is completed the tyre bead will become self sealing, in much the same manner in which it functions as a finished tyre on a vehicle wheel.

The invention is not restricted to the details of the foregoing example. Many alternatives have been given, but it will be understood that there has been described an efficient bladderless tyre mould press.

Claims

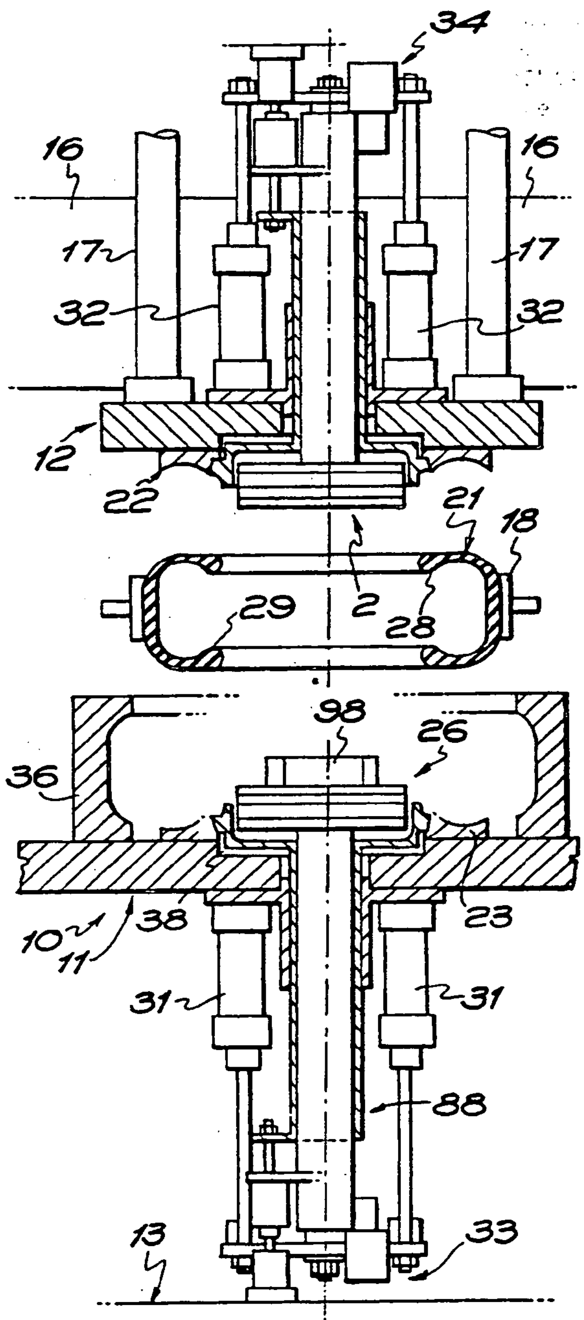
1. A bladderless tyre mould press (10) comprising lower and upper platens (11,12), means (17) for moving the platens relatively towards one another from an open position to a closed moulding position, the platens (11,12) mounting means (22,23) for moulding the tyre side walls and means (36) for moulding the tyre tread, and each of the platens (11,12) mounting means (37,38) for moulding a respective tyre bead (28,29), the tyre bead moulding means (37,38) including central means (26,27) movable relative to the respective platen for insertion into the centre of the tyre.

2. A press according to Claim 1 in which the respective central means (26,27) are each expandable from a retracted state to en expanded state.

3. A press according to claim 2 which the respective central means (26,27) each comprises a plurality of sectors (42,43) which, in the expanded state, engage with one another to provide a moulding surface for moulding the inside surface of the tyre bead.

4. A press according to claim 3 in which the sectors comprise a first outer set (42) and a second inner set (43), the sectors (42,43) from the two sets being arranged alternately and the peripheral edges (46,47) of the sectors forming a circle (44) in the expanded state.

5. A press according to claim 4 in which the sectors (42,43) of the respective sets are radially moveable between their retracted state and their expanded state in response to the rotation of respective cam plates (67,71), each sector (42,43) having an associated cam follower (66,69) engageable with the respective cam plate (67,71).


34
16
16
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32
32
12
12
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18
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2
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98
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23
10
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88
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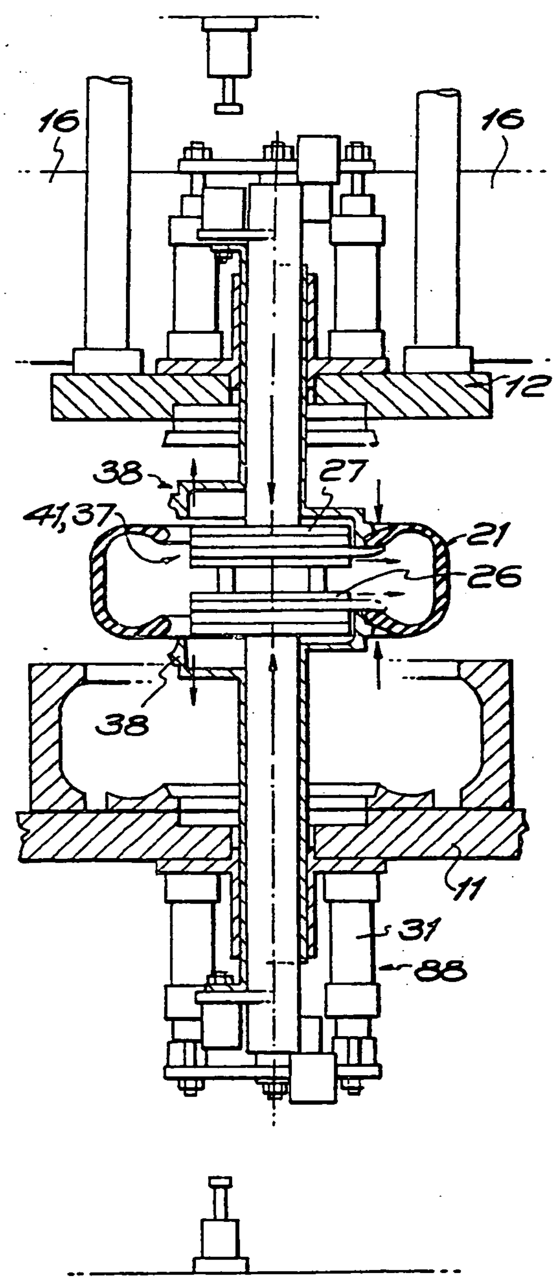
FIG.1A


16
16
12
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27
41,37
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11
31
88

FIG.1B

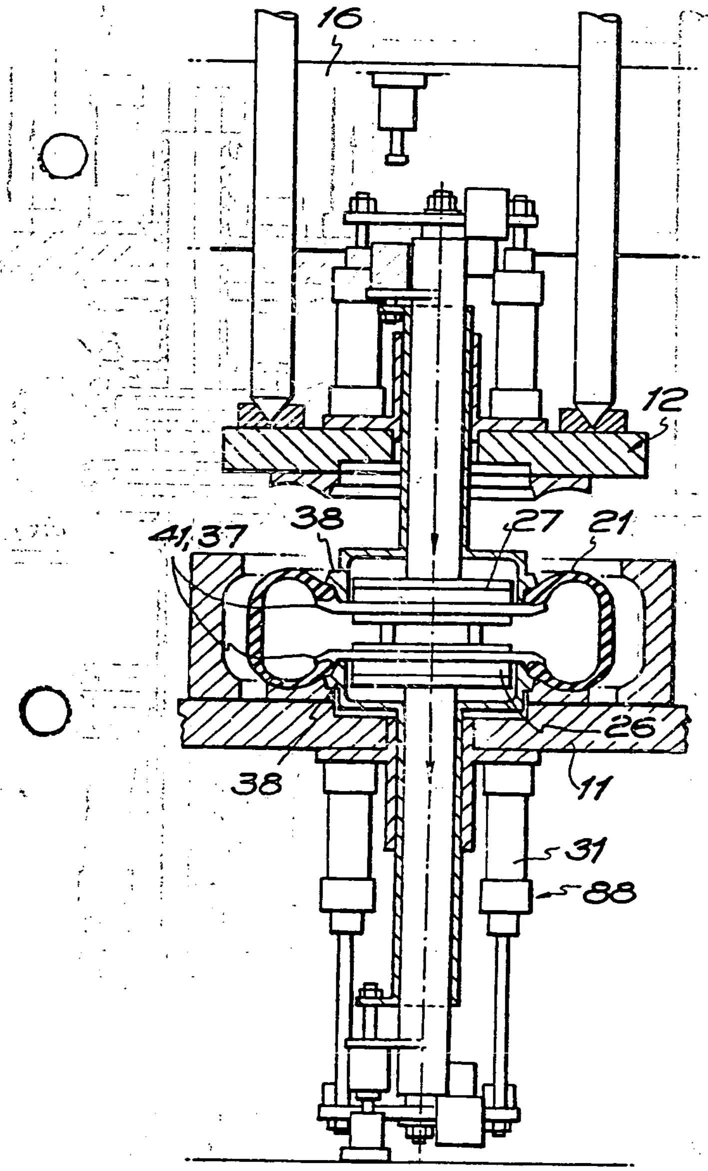

FIG.1C

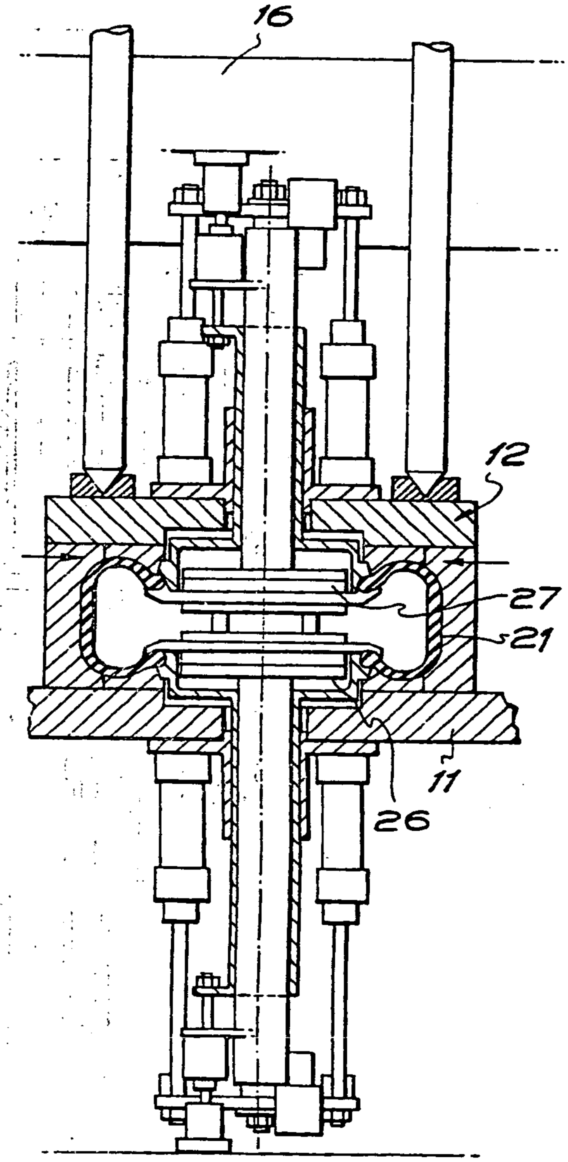

FIG.1D

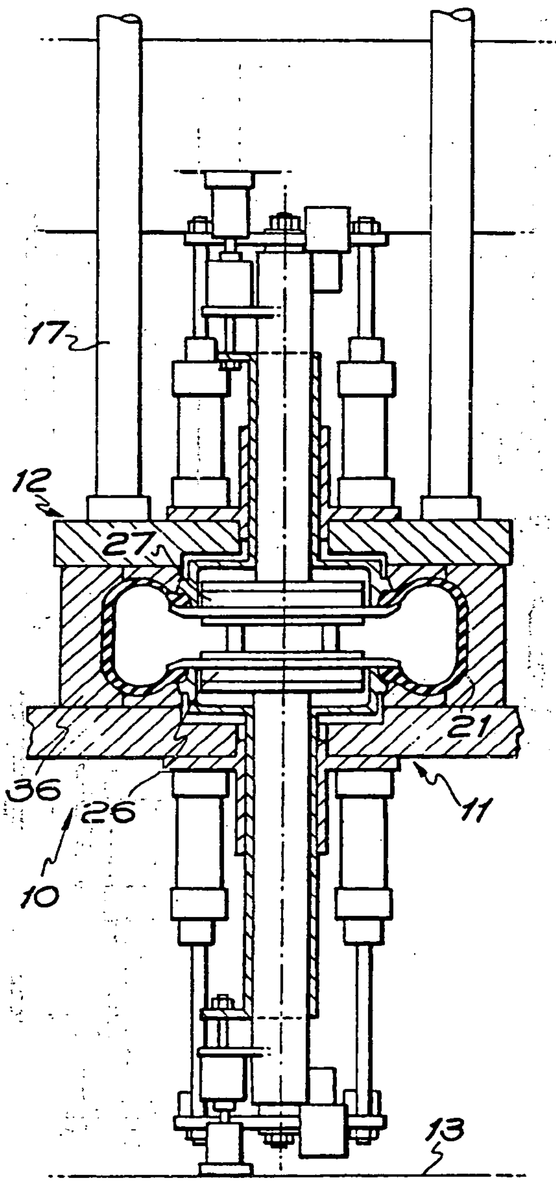

FIG.2A

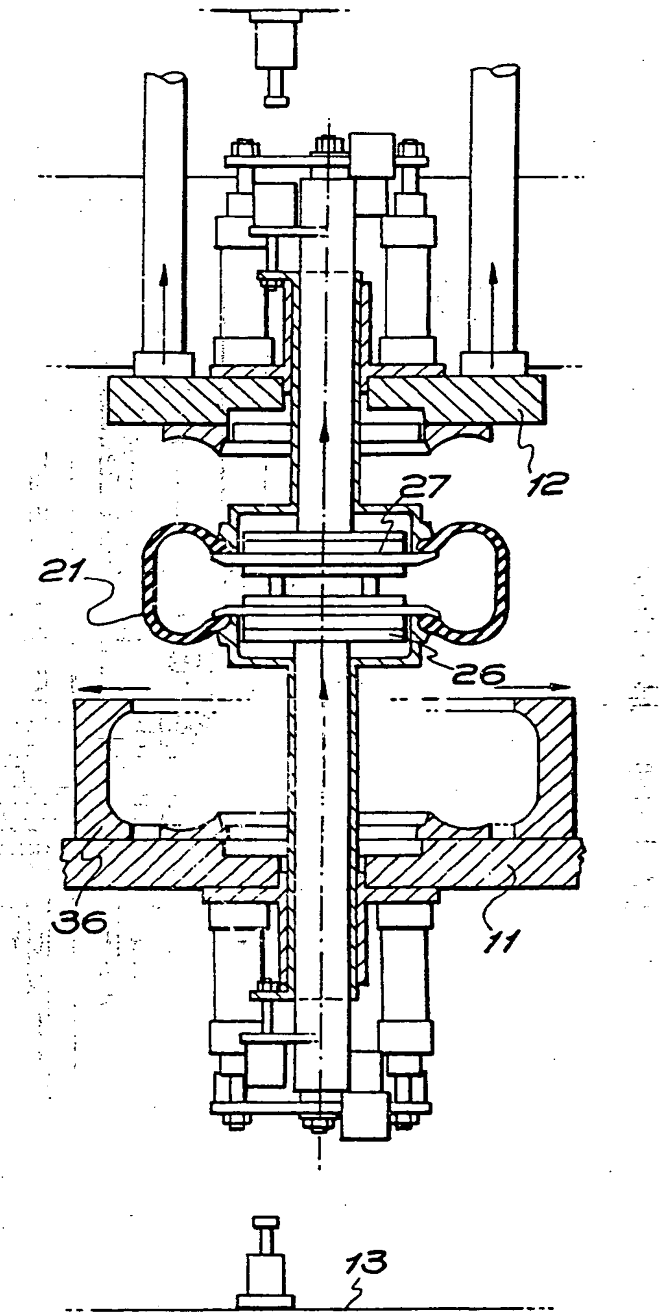

FIG.2B

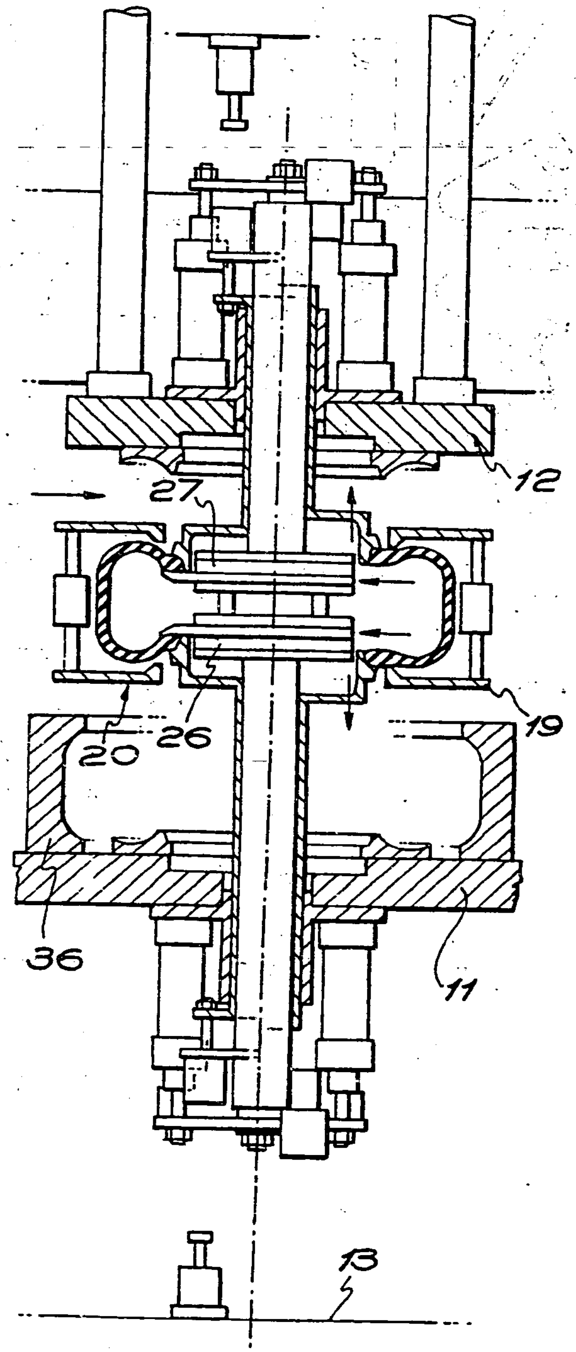

FIG.2C

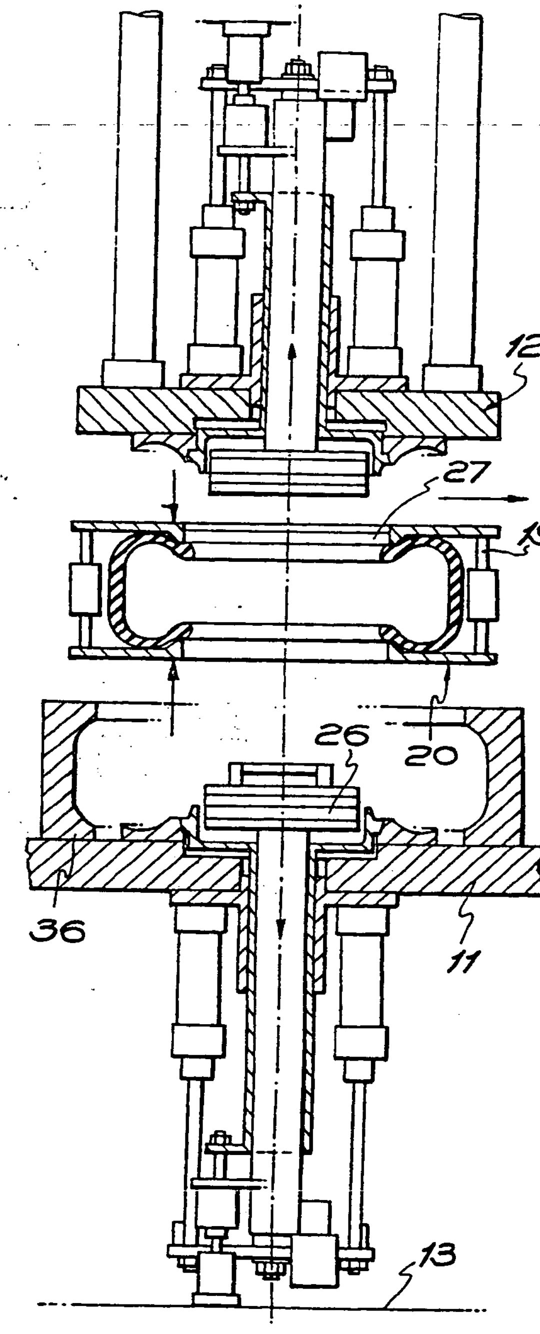

FIG.2D

Nouvellement déposé

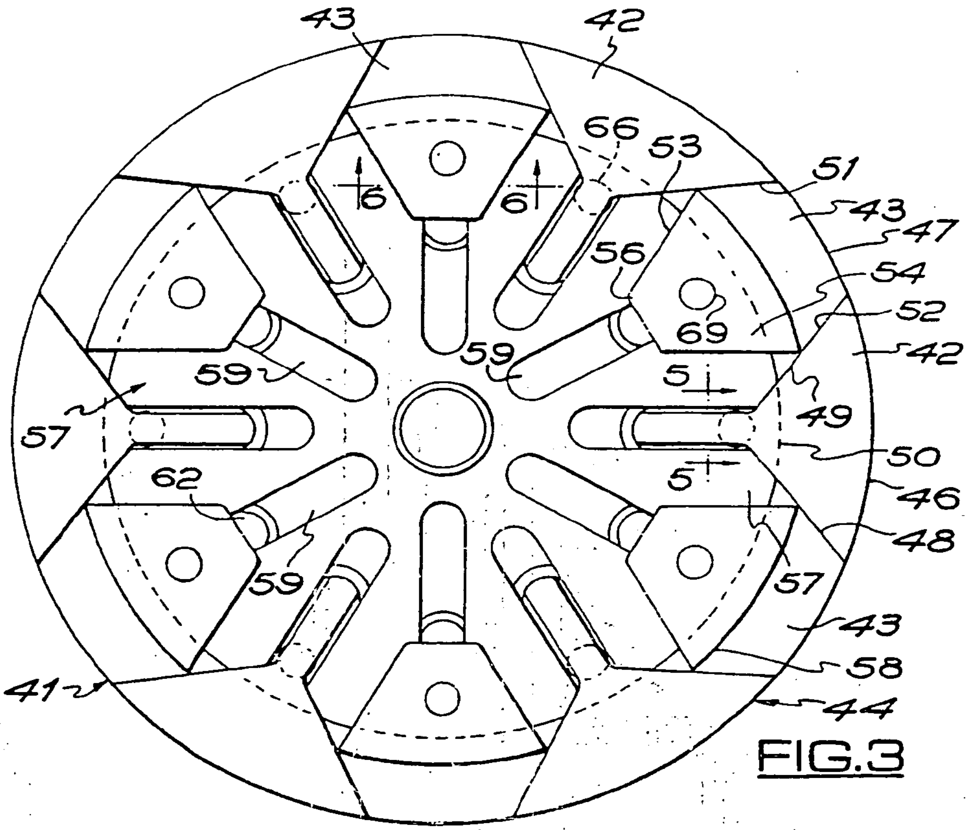

FIG.3

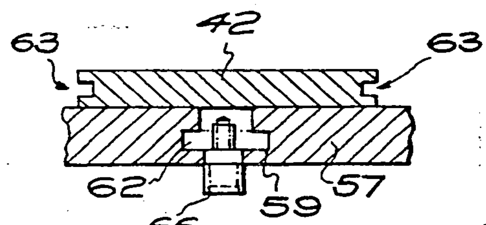

FIG.5

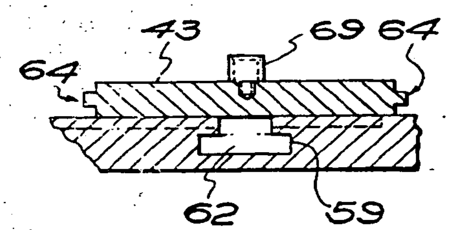

FIG.6

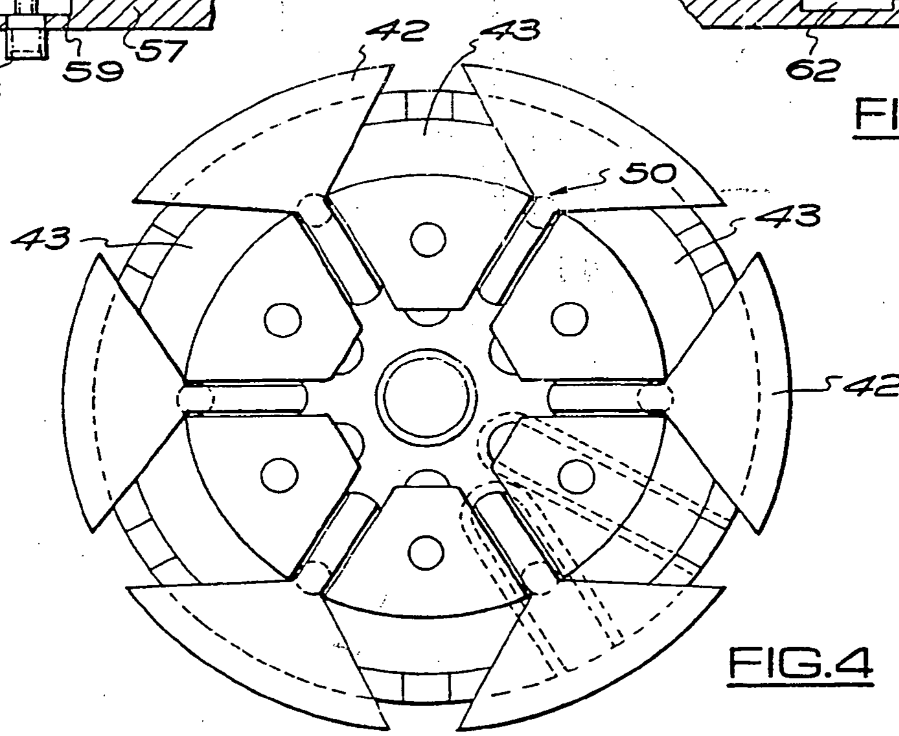

FIG.4

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Nouvellement déposé

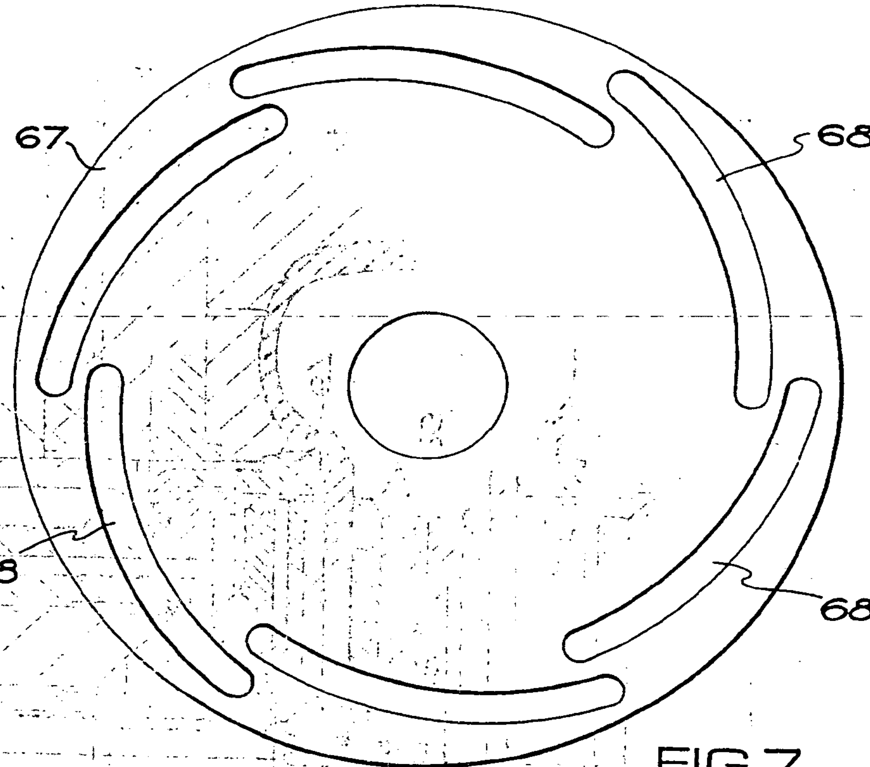

FIG.7

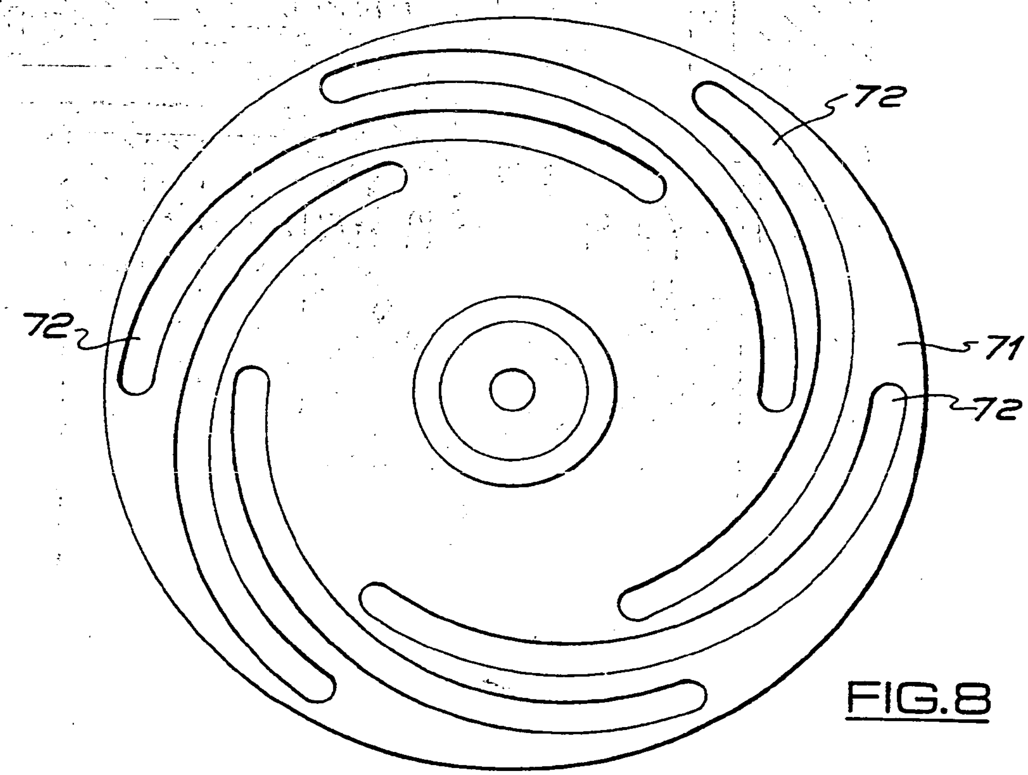

FIG.8

Nouvellement déposé

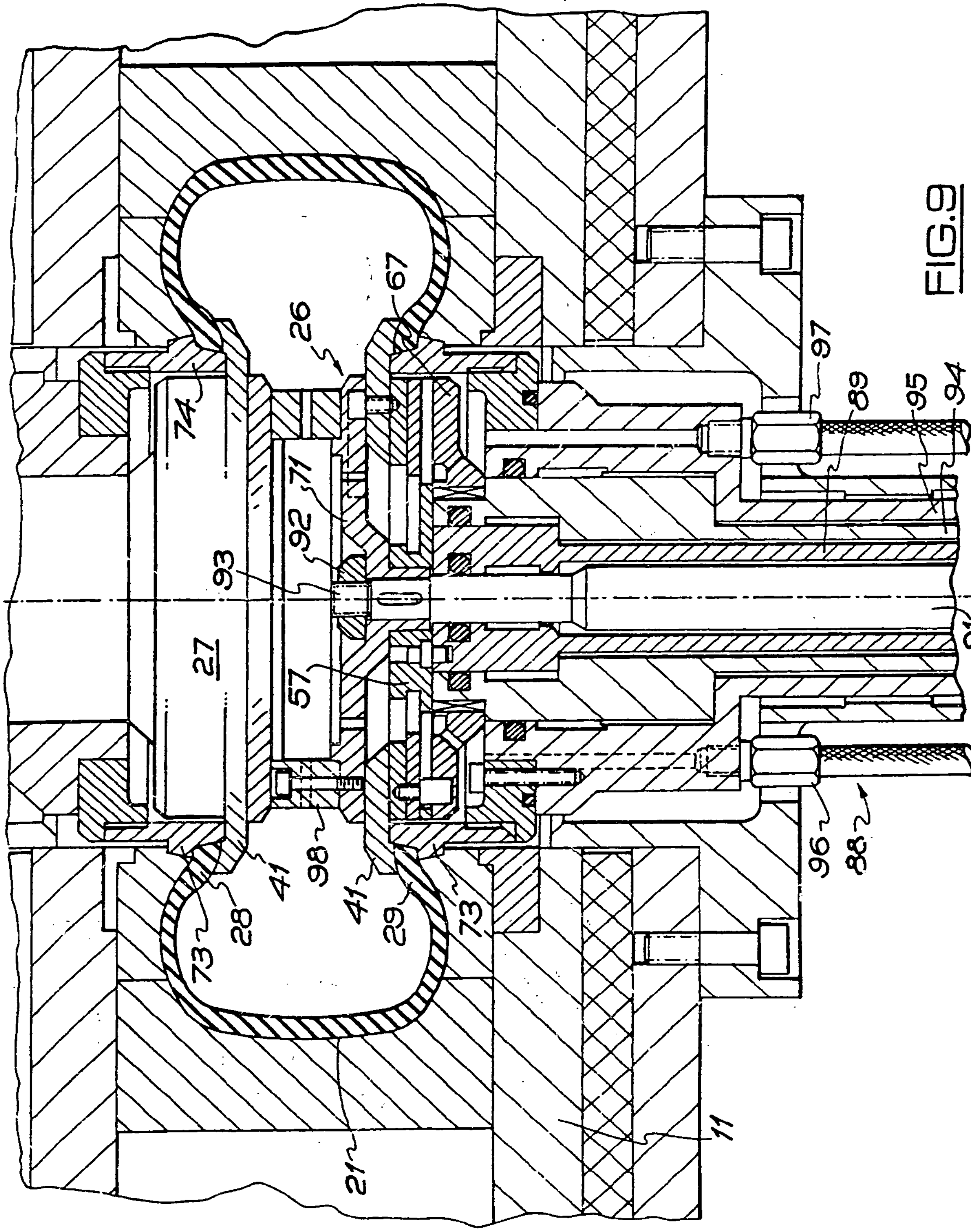

FIG.9

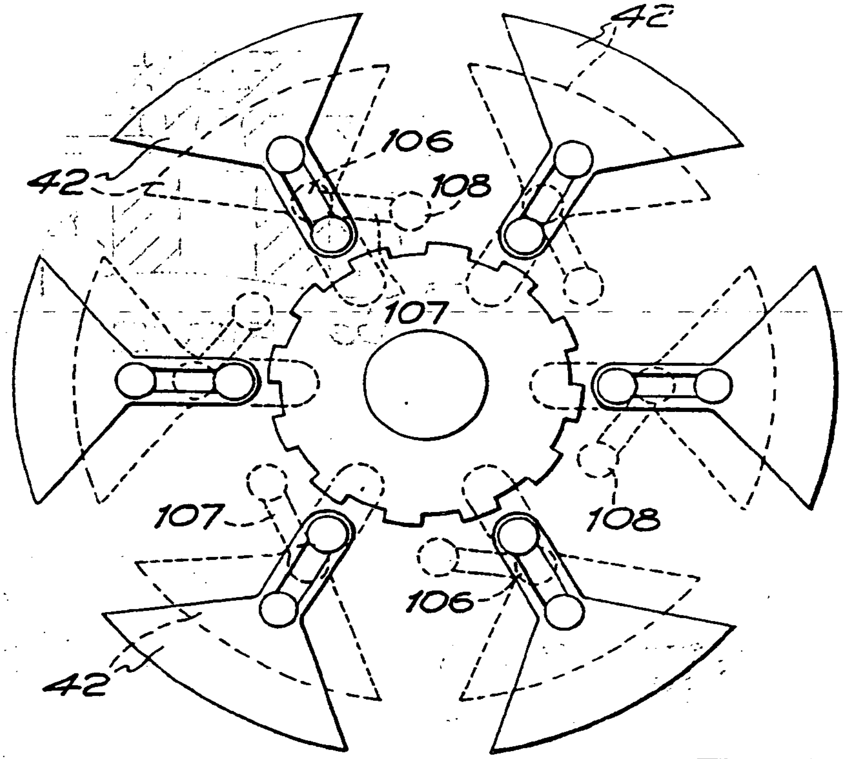

FIG.10

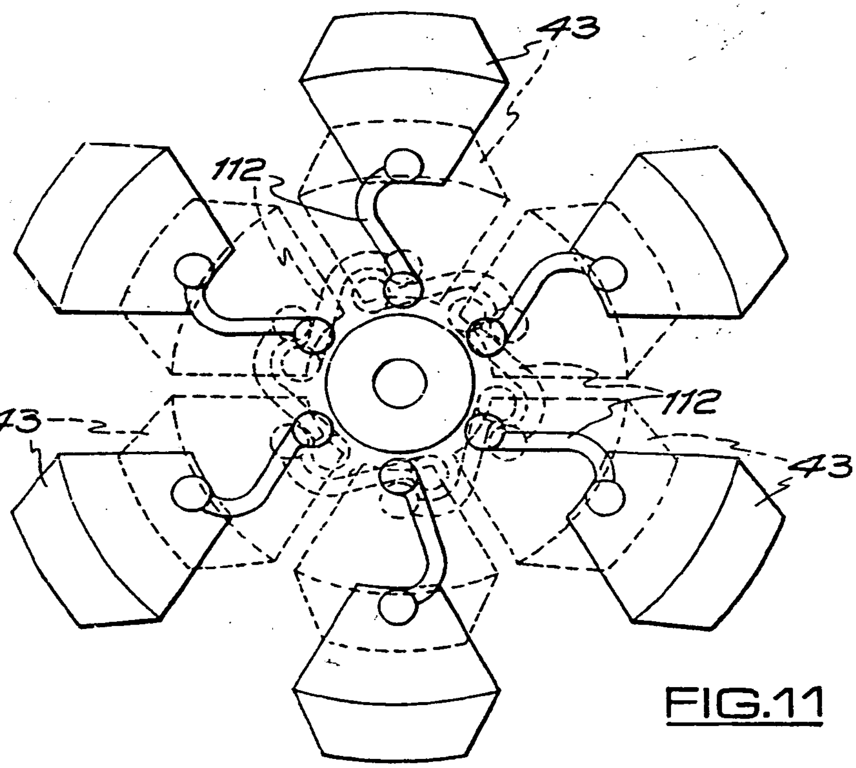

FIG.11

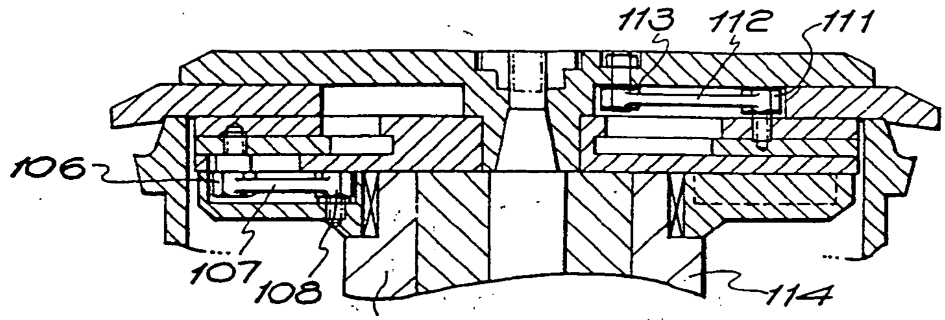

FIG.12

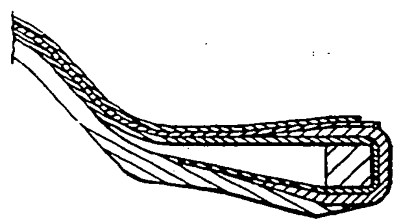

FIG.13A

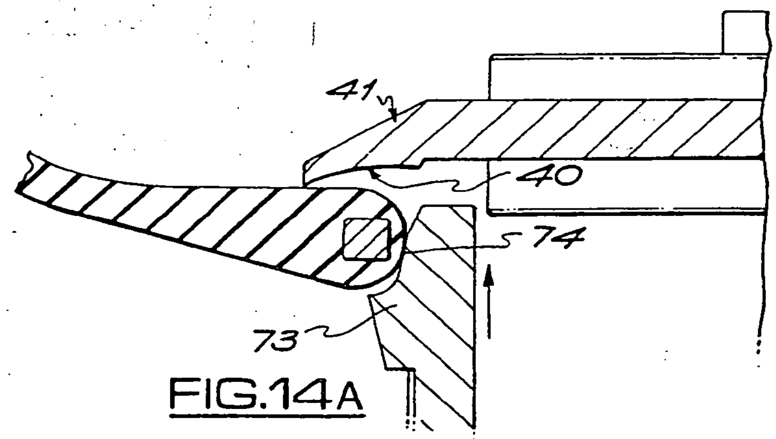

FIG.14A

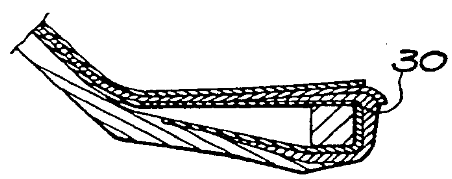

FIG.13B

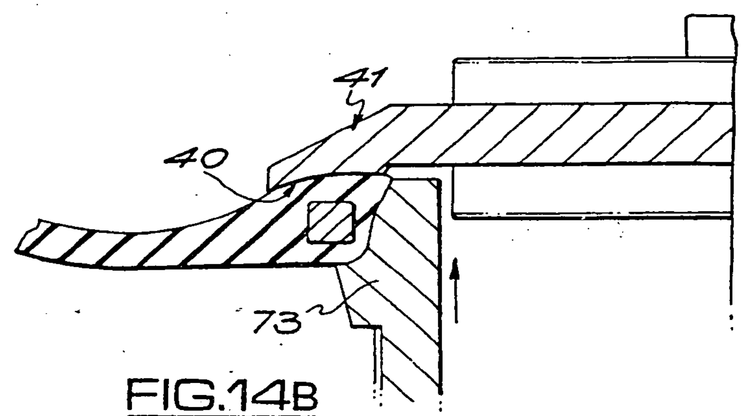

FIG.14B

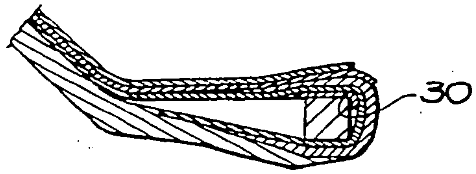

FIG.13C

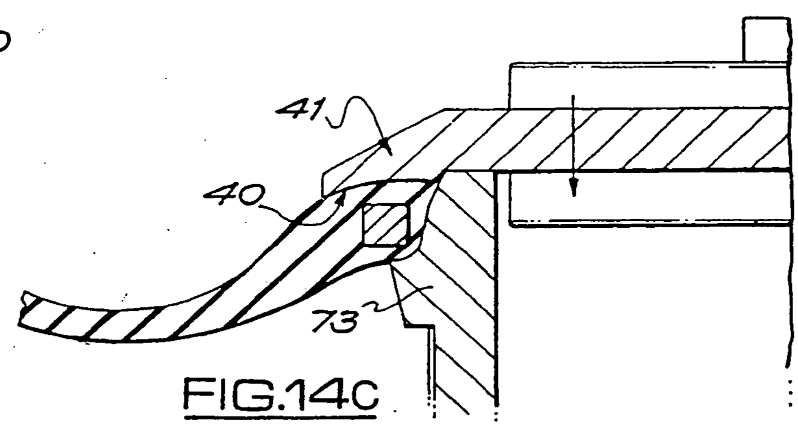

FIG.14C

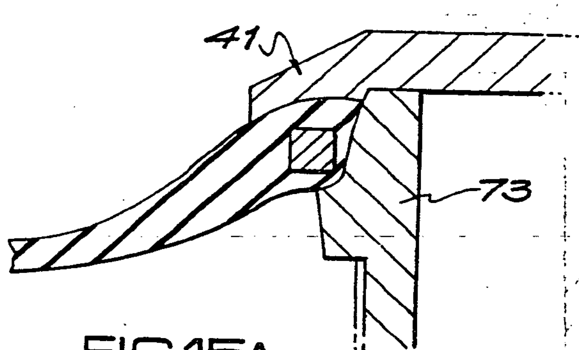

FIG.15A

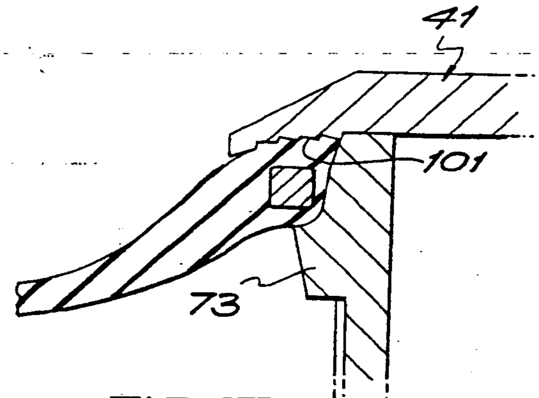

FIG.15B

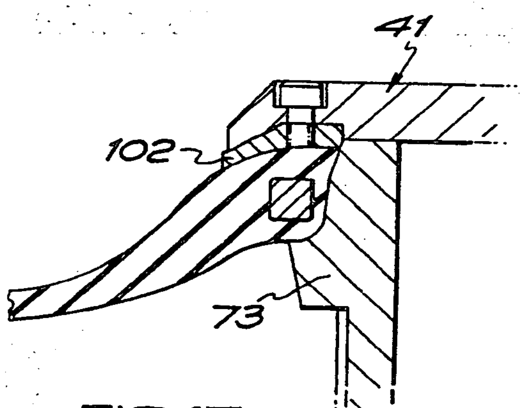

FIG.15C

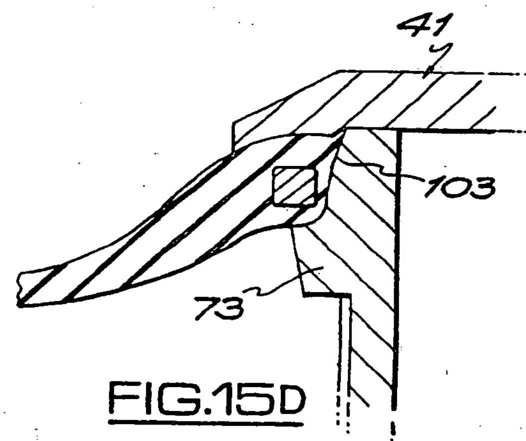

FIG.15D

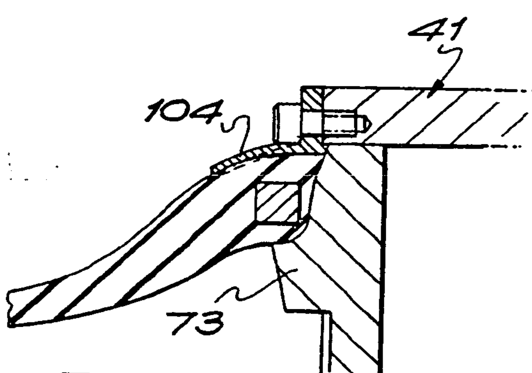

FIG.15E

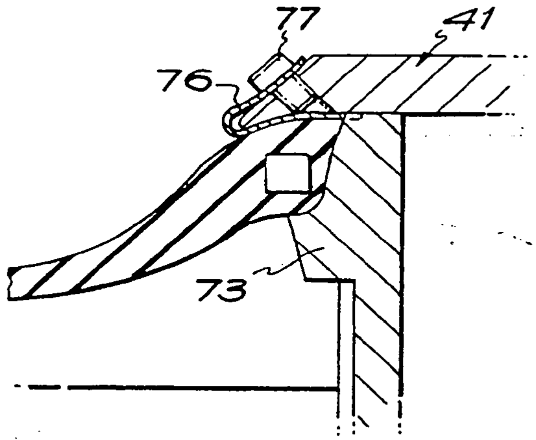

FIG.15F

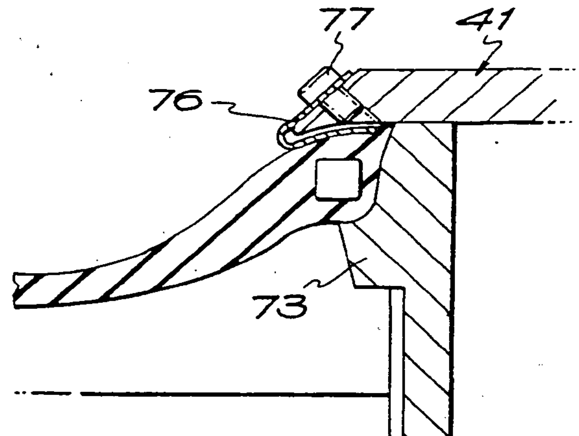

FIG.15G

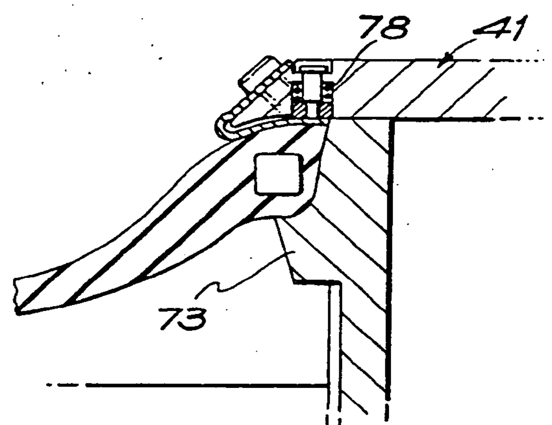

FIG.15H

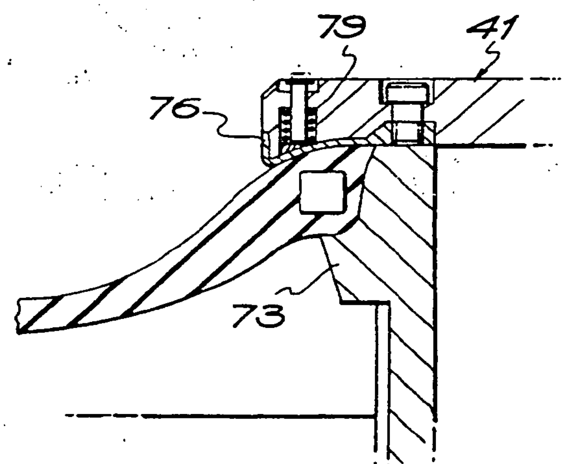

FIG.15I

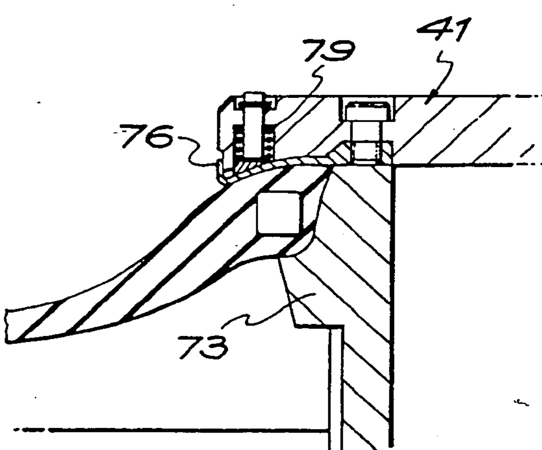

FIG.15J

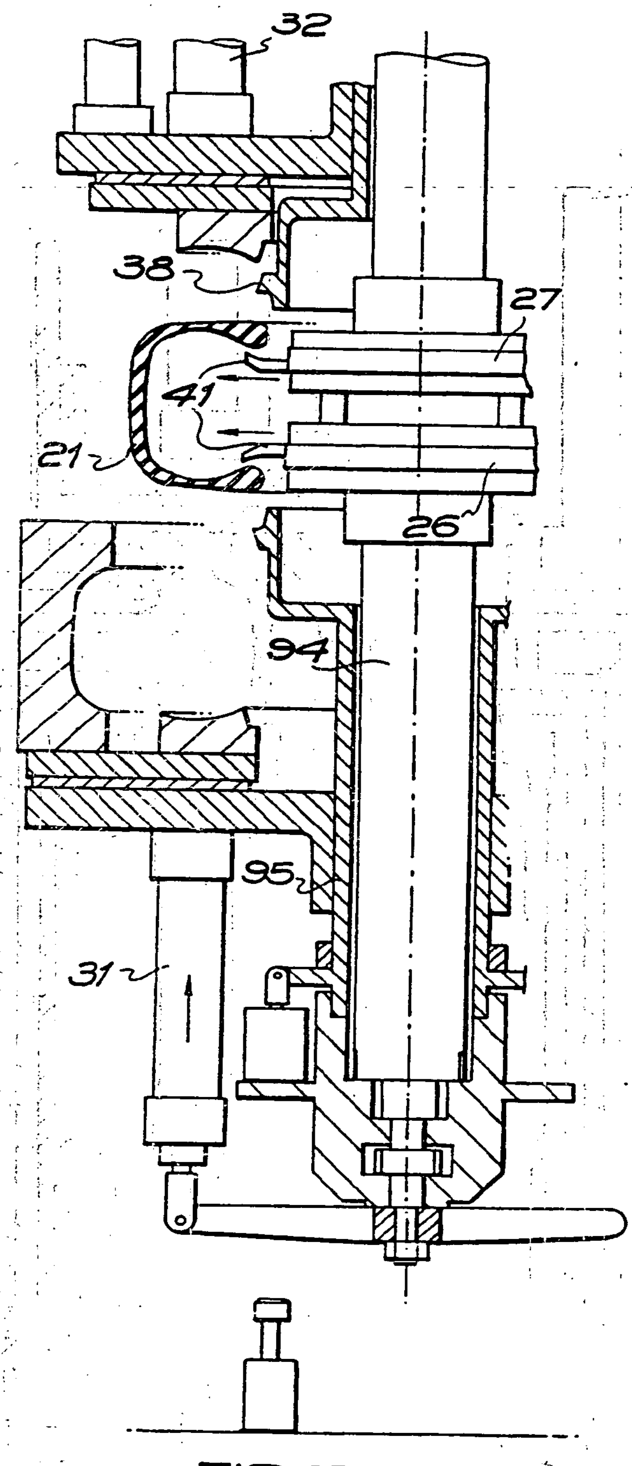

FIG.16A

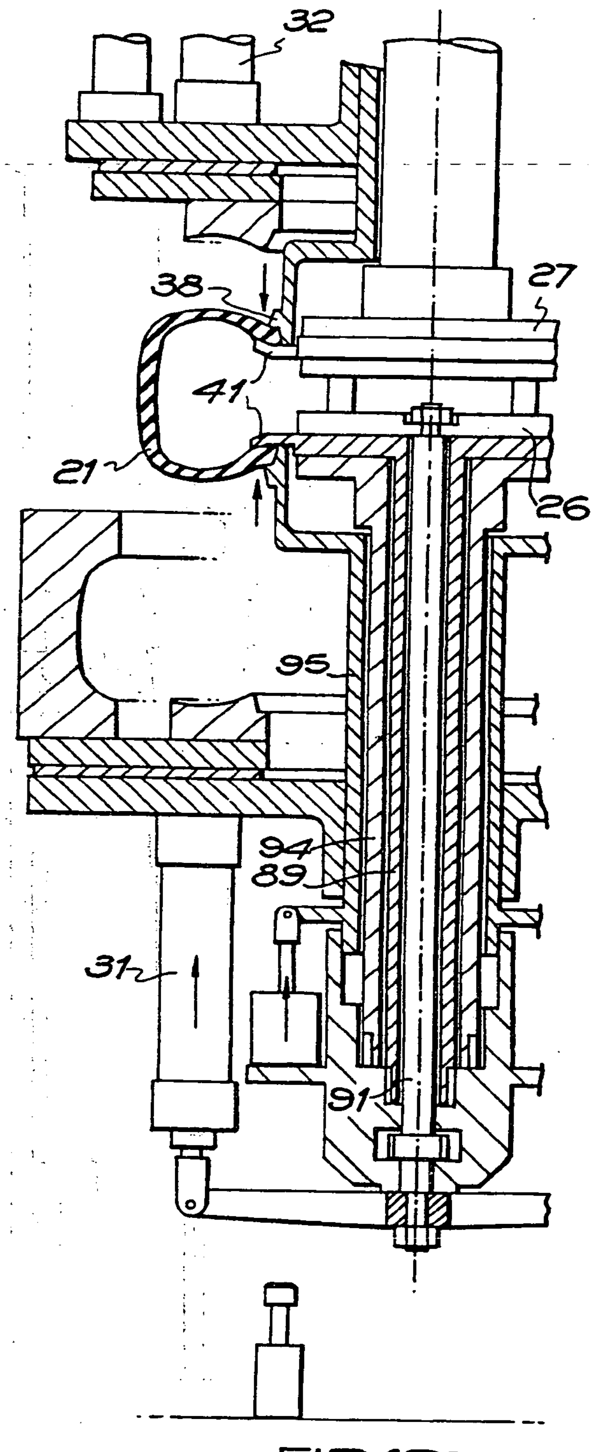

FIG.16B

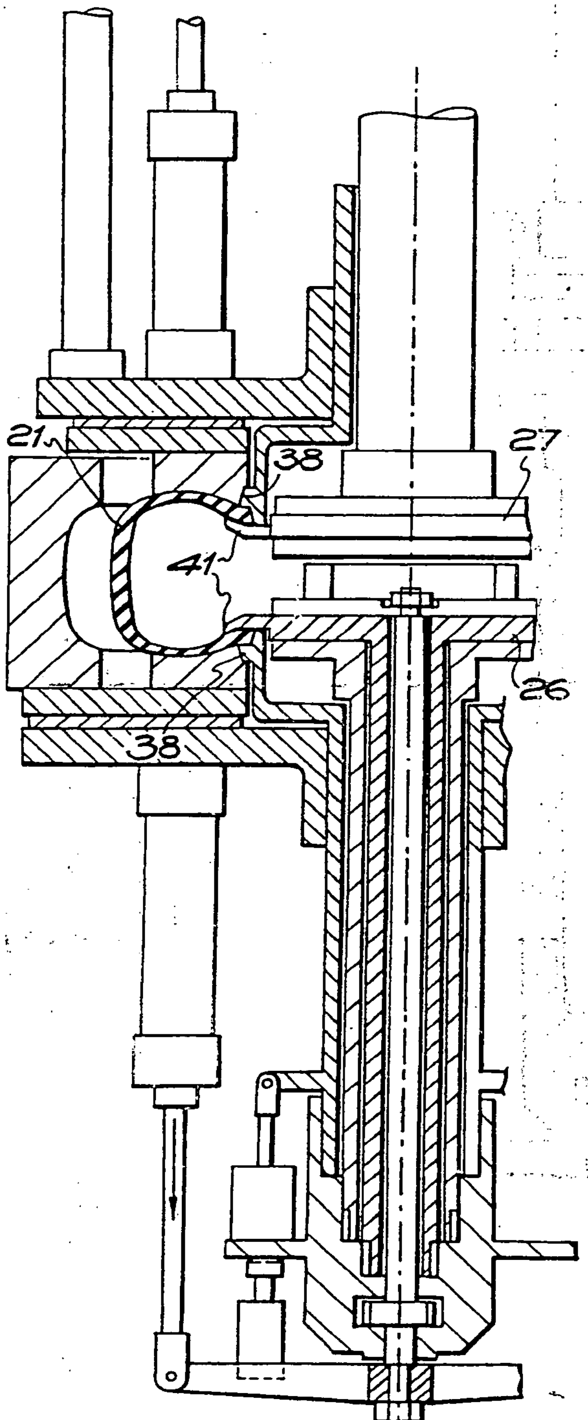

FIG.16C

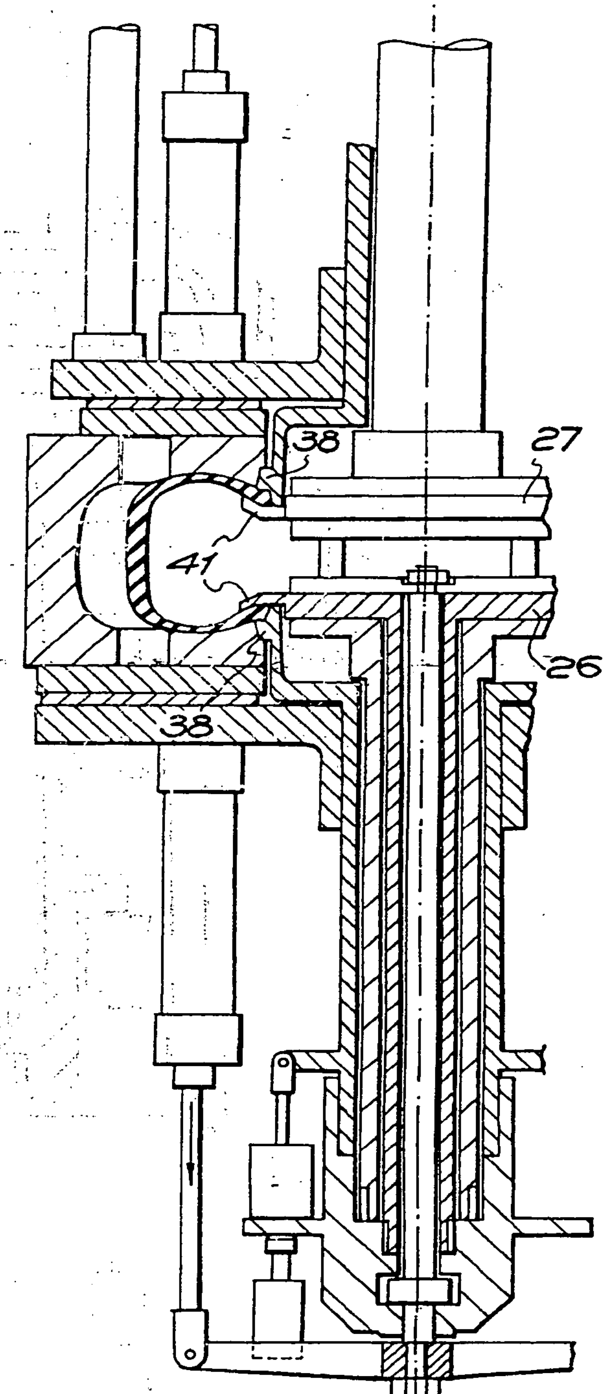

FIG.16D

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 31 1287

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	US-A-3 153 263 (E. MALLORY)	1-4	B 29 D 30/06
X	GB-A- 869 902 (McNEIL)	1-4	
X	US-A-2 959 815 (J. BRUNDAGE)	1-4	
X	US-A-2 904 832 (A. FRÖHLICH)	1-4	
X	US-A-2 939 175 (A. FRÖHLICH)	1-4	
X	GB-A- 864 443 (FIRESTONE TIRE)	1-4	
A	US-A-4 772 351 (G. THOMPSON)	5	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B 29 D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	15-01-1990	DECLERCK J.T.

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